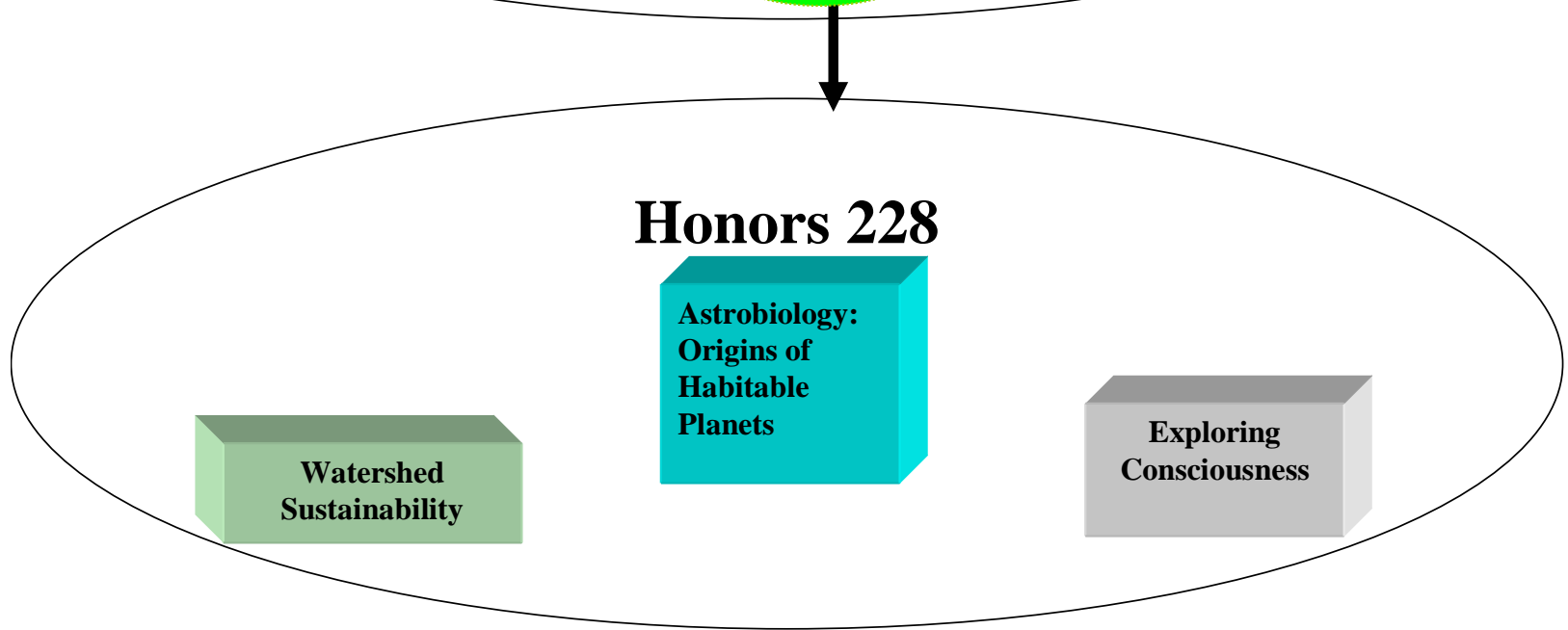
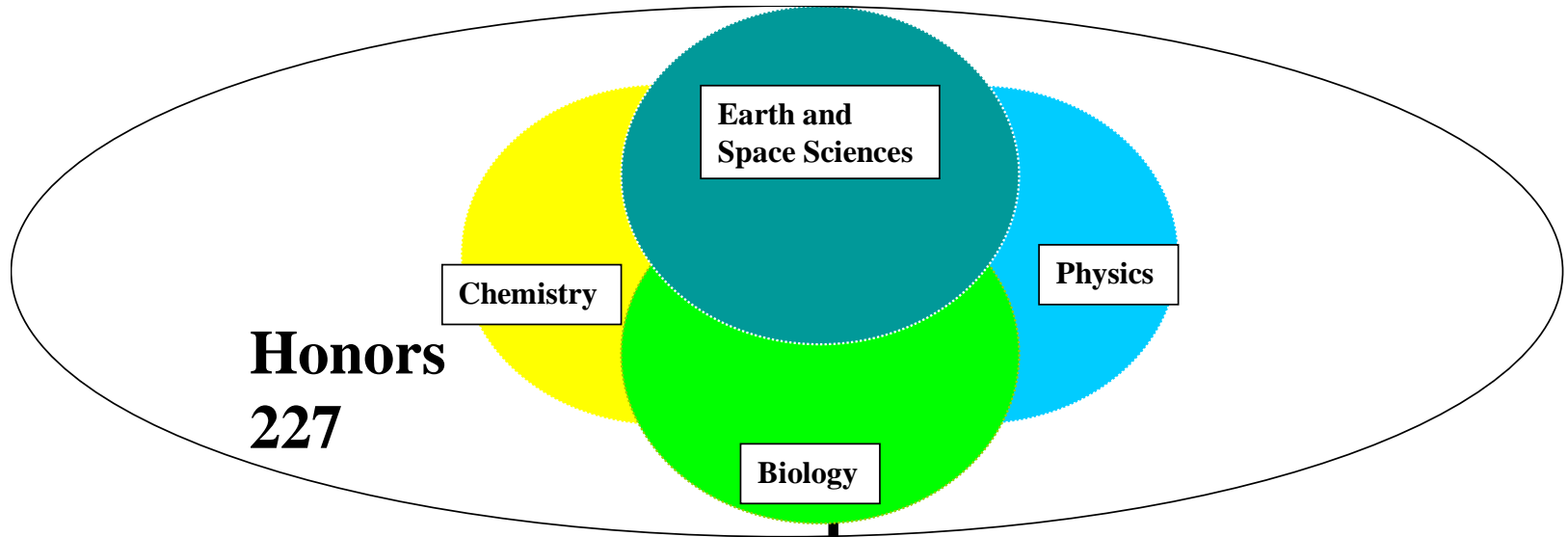


Spring 2007 Honors 228: Astrobiology with Prof. Geller Lecture No. 1

- People Introduction – Who are you?
- Course Introduction - Objectives and Goals
- Some facts and uncertainties about life in the Universe
- Debates about life, complex life, etc.
- Extremophiles on Earth
- Web Page -
<http://physics.gmu.edu/~hgeller/astrobiology>



Synopsis

This course will study the origin and development of life on the planet Earth within the context of an evolving universe. We review the origins of the universe from the "Big Bang" to our own solar system and integrate the principles of physics, chemistry, geology and biology to study the origins of life on Earth. We address the ultimate fate of life in the universe based upon our understanding of thermodynamics, expansion of the universe, and properties innate to all living systems.

Synopsis Continued

The essential features of all living systems are discussed as they relate to what we might expect in terms of life elsewhere in the universe. This analysis is based on features of living systems on Earth (plant, animal and microbe), including those from very extreme environments (extremophiles).

Synopsis Continued

The labs are an integral part of the course and include computer simulations and exercises from the activities manual that should help you understand essential features of the (i) origins of the universe; (ii) life on the planet Earth; (iii) search for life on Earth and elsewhere in the universe; and, (iv) extraterrestrial space travel and exploration.

Grading Policy

• Homework	25%
• Mid-Term Exam	15%
• Laboratories	25%
• Class Participation	20%
• <u>Final Exam</u>	<u>15%</u>
• TOTAL	100%

Course Format

- Lectures
- Laboratories (25% of grade)
 - Mandatory and on time
 - Deductions for late hand-ins/absences (2/10 if not done with group + 1/10 each day late)
 - You cannot join group if you are late to lab
- Examinations
 - Mid-term Exam (15%)
 - Final Exam (15% and **comprehensive**)
- In-Class Discussions and Participation (20%)
 - Mandatory and on time
 - Deductions for late hand-ins/absences (2/10 if not done with group + 1/10 each day late)
- Homework (25%)

Resources

- Textbook
 - Jeffrey Bennett and Seth Shostak, *Life in the Universe (2nd edition)*. Addison Wesley Publishers, Inc., New York, NY
 - Benefits
 - Readability
 - Organization (integration)
 - Integration of biology, chemistry, and physics
 - Somewhat current (published in 2006)
 - Liabilities
 - Incomplete nature of the text; some of HNRS 227 repeated; not enough in-depth; not enough math; not new anymore (update pending)
- Activities Manual
 - Life in the Universe Activities Manual by Prather, Offerdahl and Slater
- Other resources
 - software, web, articles, quotes

Principle Course Objectives

- Origins of life on Earth and in the Universe
- Scientific method and philosophy of science
- Physical laws that govern the interaction of matter, energy, time, and space in the Universe
- Role of electromagnetic radiation in understanding the physics, chemistry and biology of distant planets and stars

Principle Course Objectives (continued)

- Magnitude of the problem in searching for life in the Universe
- Biochemical properties of living systems essential to all life irrespective of its place in the Universe
- Exploration of the Universe: physical, chemical and biological constraints
- Cybernetics of life on any planet: living systems affect the habitability of their environment

Major Topics

- Origin of the Universe
- Origin of our solar system and the planetary systems
- Physics of light, gravity, matter, energy, magnetism, radioactivity, nuclear energy and relativity
- Geology of volcanism, plate tectonics, atmosphere, and erosion as applied to all planets

Major Topics continued

- Birth and death of stars and galaxies
- H-R diagram and its role in understanding the evolution of all stars
- “Big Bang” theory of the Universe’s creation
- Stellar and galactic evolution
- Cosmology and life in the Universe

Major Topics cont

- Biochemical machinery of all living organisms
- Evolution of life on Earth
- Uniqueness of the organisms on Earth inhabiting very extreme environments (extremophiles)
- Physics, chemistry and biology of space exploration and habitation
- Principle of habitability and the role of biota in controlling the environment (Gaia)

Certainties and Uncertainties

- Aliens have already visited Earth (50%)
- Evolution of astrobiology
 - Geocentric view of Earth
 - Hierarchical view of the Universe
 - Universe (one or many)
 - Galaxies (~150 Billion Galaxies)
 - Milky Way (~400 Billion Stars)
 - Solar System (Sun, planets, etc.)
 - Earth
 - Life
- Time: ~14 Billion years

Certainties and Uncertainties

- Stars and the “Stuff of Life”
 - All stars pass through a defined cycle
 - Fuel of all stars (H and He)
 - Subsequent evolution results in remaining elements (e.g., C, S, N, O, Fe, etc.)
 - Example: atom of C in your body...trace its origin???
 - “Star Stuff”
- Universality of Principles
 - Physical Laws (examples)
 - Chemical Laws (examples)

Certainties and Uncertainties

- Universality of living systems
 - Principles of biology comparable to the universality of physics and chemistry?
 - What are some of the principles of biology (e.g., C based metabolism)
- Environmental Conditions
 - What are conditions under which life could exist?
 - Examples of life on Earth

In-Class Discussion

- Great Debates in Astrobiology
 - The “rare Earth hypothesis”
 - life may be widespread but complex life is so unlikely that it isn’t anywhere else in this galaxy
 - How far away might the nearest intelligent life form be?
 - What limits might we be reasonably able to establish?
 - Fermi’s Paradox
 - Where are the aliens if they are so common?
 - Carbon chauvinism
 - Can complex life only be based upon carbon molecules
 - Earth-like conditions for life
 - Can life develop in extreme environments?

In-Class Discussion

- Key requirements of living systems
 - Interaction with environment, get energy, consume food
 - How to measure?
 - Examples?
- Extreme environments
 - What environments would not support life on Earth?
 - How to determine?
 - What are they (examples) and where are they?
- Extremophiles
 - Organisms that exist in extreme environments
 - How to determine?
 - What examples?